*Three planes on merging routes are:*
*-- different distances from the intersection,*
*-- traveling at the same speed.*
*An alternate route is available.*

# *LINEUP WITH MATH*™

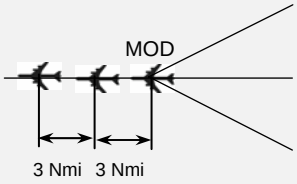
**Math-Based Decisions in Air Traffic Control for Grades 5 - 9**

## Problem Set C

**Resolving 3-Plane Traffic Conflicts by Changing Route**

## Teacher Guide with Answer Sheets

### Overview of Problem Set C




Goal

*Estimated class time: 1-1.5 hours*

In this Problem Set, students will determine whether three planes traveling on different merging routes will line up with proper spacing at MOD (the last intersection before the planes leave the airspace sector). If the spacing is not adequate, students will use alternate routes for one or more planes to achieve at least the proper spacing.

The planes are traveling at the same altitude and the same constant (fixed) speeds.

In *LineUp With Math*™, this is the first Problem Set to address three planes. Speed changes are not required to resolve spacing conflicts.

Each problem can be explored with the interactive Air Traffic Control (ATC) Simulator. Two of the problems can be more closely examined with Student Workbook C (print-based). The Workbook provides a structured learning environment for exploring the problems with paper-and-pencil worksheets that introduce students to pertinent air traffic control concepts as well as problem analysis and solution methods.

### Objectives

Students will:

- Analyze a sector diagram to identify spacing conflicts among three planes, each traveling at the same speed.
- Resolve spacing conflicts by changing the route for one or more planes.

### Prerequisites

Before attempting the current Problem Set, it is *strongly* recommended that students complete Problem Set A that provides essential air traffic control vocabulary, units, and representations.

It is also recommended that students complete Problem Set B that introduces the ATC Simulator and enables students to explore the effects of a route change in a two-plane problem.

## Materials

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- ATC Simulator (web-based)
- Student Workbook C (print-based)

The materials are available on the *LineUp With Math™* website:

http://www.smartskies.nasa.gov/lineup

A separate student website gives students easy access to the Simulator only (and not to the answers and solutions provided on the teacher website):

http://www.atcsim.nasa.gov

## ATC Simulator

*A complete description of the ATC Simulator is contained in the Educator Guide for LineUp With Math™.*

*For a Simulator user guide and an animated tutorial, visit the LineUp With Math™ website.*

**Interactive Air Traffic Control Simulator**

Students can explore Problem Set C with the interactive ATC Simulator. Each problem features a 3-plane conflict that can be resolved by a route change.

The Simulator problems for Problem Set C are:

3-1*; 3-2*; 3-7

Problems with an asterisk (*) are supported by worksheets in Student Workbook C.

For a complete set of answers and solutions to all Problem Set C Simulator problems, see Appendix I of this document.

For a discussion of the key points associated with the first two Simulator problems, see the worksheet notes in the following Student Workbook section.

## Student Workbook

*It is recommended that you have a copy of Workbook C open while you read these notes.*

*Each worksheet title is the same as the associated Simulator problem.*

The Student Workbook consists of two worksheets, one for each of the two featured Simulator problems listed below.

| Simulator Problem | Worksheet Title |
|---|---|
| 3-1* | Problem 3-1 |
| 3-2* | Problem 3-2 |

Each problem features a spacing conflict with different starting conditions. As students progress through the worksheets, they likely will require less guidance and structure, and the subsequent worksheet reflects this.

For a complete set of answers to each worksheet, see Appendix II of this document.

For each worksheet, the key points are briefly described as follows.

*In the sector diagram, each route flows only **towards** MOD. E.g., a plane may fly from MINAH to OAL, but cannot fly from OAL to MINAH.*

**Worksheet: *Problem 3-1: Assure Spacing Among 3 Planes***

- On a number line, students plot each plane's travel distance from MOD to help picture the arrival order of planes at MOD, their relative spacing, and any spaci violations,
- After students resolve a spacing violation with a route change, they again use a number line to picture the planes' new arrival order and spacing.

**Worksheet: *Problem 3-2: Assure Spacing Among 3 Planes***

- This problem is similar to Problem 3-1. However, in this problem, students are expected to analyze and identify the conflict on their own. Minimal structure is provided to guide the students to a solution.

**Answer Sheets**

*For a set of answers and solutions to all Simulator problems, visit the LineUp With Math™ website.*

Answer sheets for each of the Problem Set C Simulator problems can be found in Appendix I of this document.

Answer sheets for each worksheet in Student Workbook C can be found in Appendix II of this document.